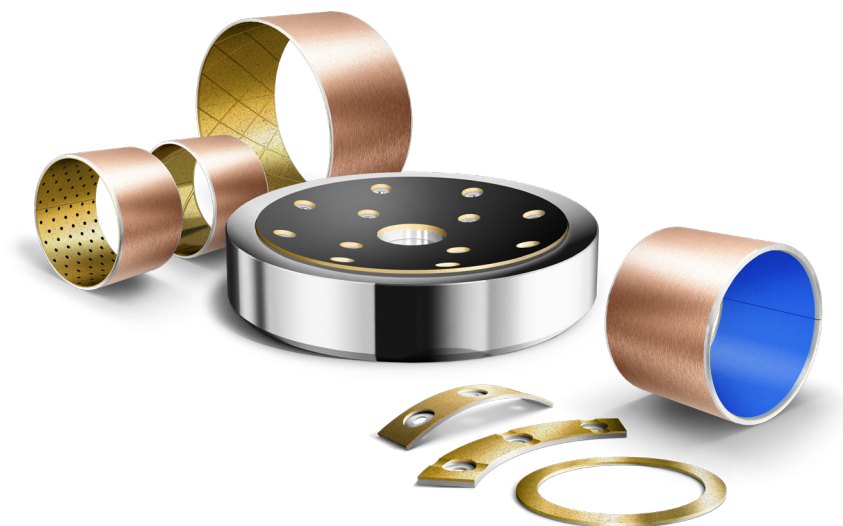


Technical manual

deva _bm[®]



Your challenges are our fascination.

Self-lubricating bi-metal sliding bearings

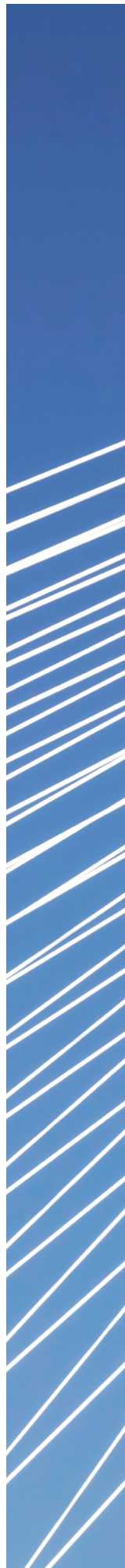
For more than 85 years, the name DEVA® has stood for self-lubricating, maintenance-free high-performance materials and sliding bearing solutions. Since the development of the world's first powder-metallurgical material with embedded solid lubricants in 1936, DEVA® sliding bearings perform where other bearings reach their limits.

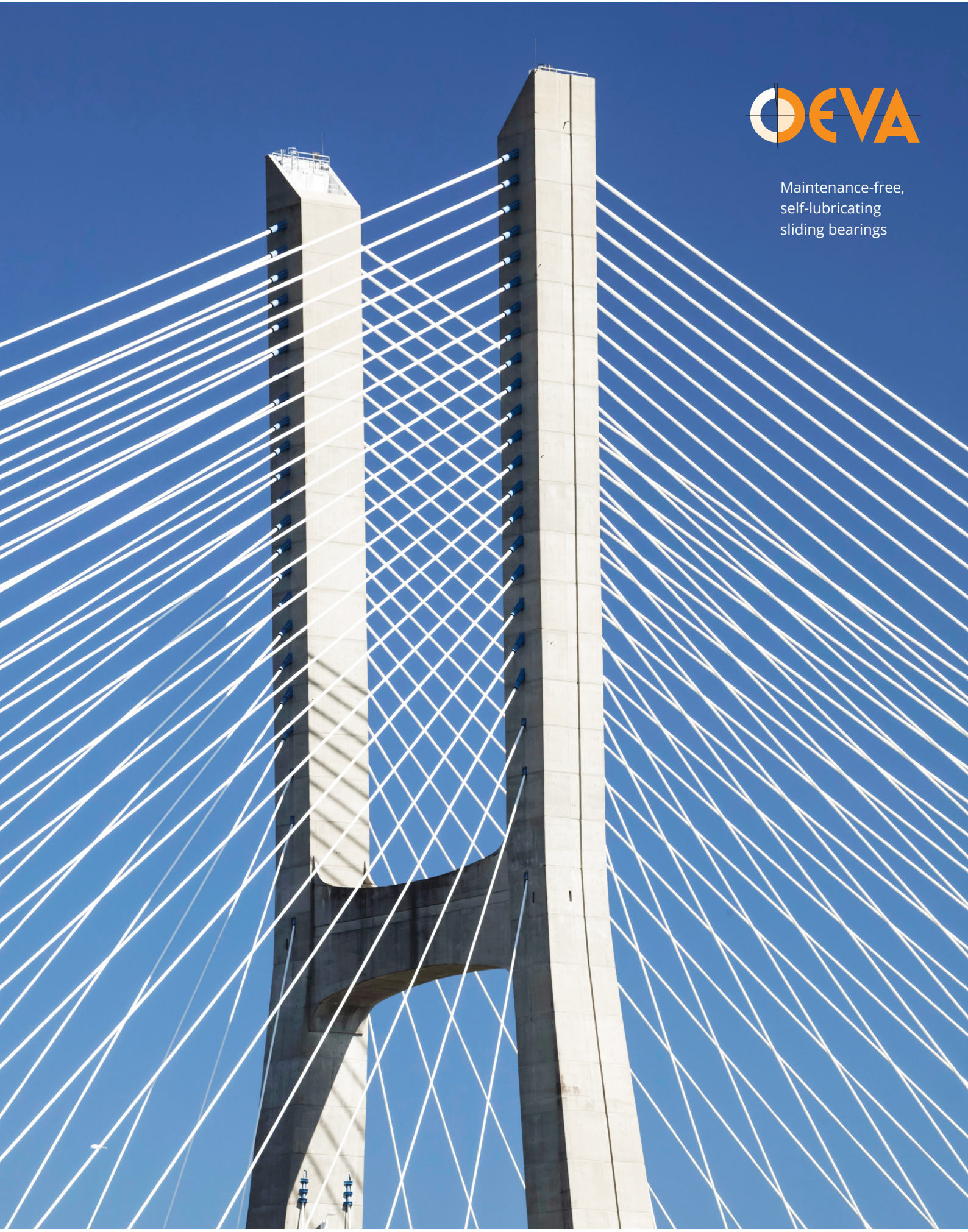
Our sliding bearing materials are used in a wide range of industrial applications.

Wherever it matters: under water, at freezing temperature or hot heat, DEVA® is the world's first address for maintenance-free, self-lubricating sliding bearings. In addition to standard components, we offer optimized sliding bearing solutions designed and developed in close cooperation with our customers.

We support you during

- Selection of sliding materials
- Design elaboration and individual adaptation to your requirements
- Estimation of bearing life
- Simulation of your sliding bearing application on our test rigs
- Assembly and installation





Maintenance-free,
self-lubricating
sliding bearings

The continuous development of our products and manufacturing processes is our objective.

Continuous development is the basis for a wide range of customer-specific and standardized bearing elements. Constantly improving requirements such as longer service life and maintenance intervals, optimized friction coefficients and environmental compatibility are taken into account.

Typical applications for deva.bm® sliding bearings can be found in these industries:



Iron and steel industry



Hydro-Civil Engineering



Bridges and steel construction



Mechanical engineering



Injection molding and tire molding



Food and packaging machines



Shipbuilding and offshore industry



Onshore and offshore wind turbines



Railway vehicles



Gas and steam turbines



Agricultural and construction machines

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deva.bm® sliding bearings

Material properties

Maintenance free and self-lubricating high-performance sliding material

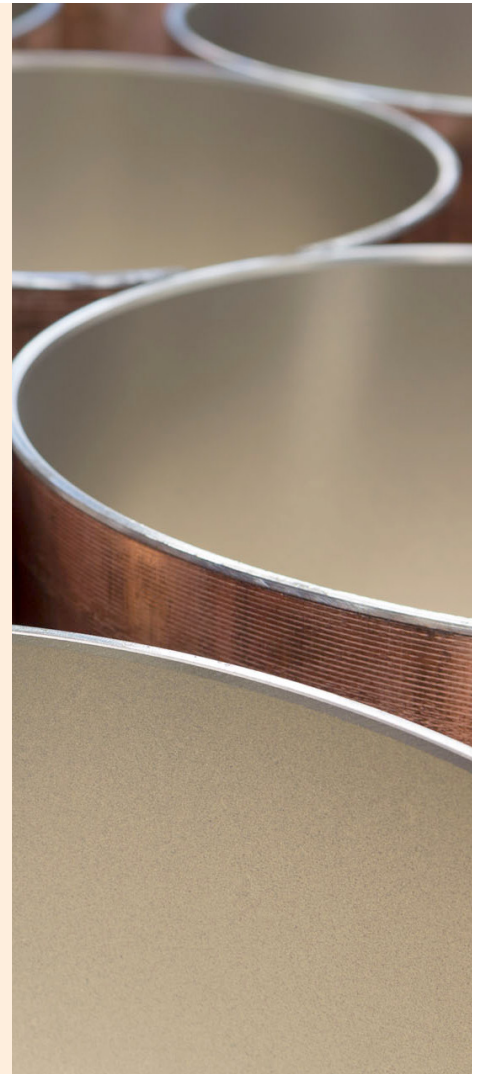
deva.bm® is a bi-metallic material consisting of a steel strip as a supporting backing layer and a sintered self-lubricating bronze sliding layer. The solid lubricant (graphite or PTFE) embedded in the sliding layer under pre-stress enables maintenance-free application of the sliding bearing.

The maintenance free and self-lubricating material is available in different alloys and variants as well as material thicknesses. The two-layer material structure allows compact and heavy-duty bearing concepts with high functional reliability.

During the sliding process between the bearing and the mating material, the embedded solid lubricant is released by micro-abrasion. This forms a separating layer between the two sliding surfaces. The so-called “third body” prevents welding (“seizure”) of the sliding pair, and the occurrence of stick-slip effects is reduced to a minimum.

Performance promise Our deva.bm®

- Enables maintenance-free operation
- Has a high static and dynamic load capacity
- Has a low coefficient of friction
- Offers high security against damage to the mating material
- Can be used in dusty environments
- Can be used in temperature ranges from -190°C to $+280^{\circ}\text{C}$
- Can be used in corrosive environments
- Allows additional lubrication if required
- Does not absorb water and ensures maximum dimensional stability
- Can be used in marine environments and saline water
- Can be used in radioactive environment
- Is electrically conductive; no electrostatic charging effects occur
- Is suitable for rotating
- Oscillating and linear movements
- Is suitable for micromovements



deva.bm® sliding bearings

Sliding bearing materials

Steel backing and bronze matrix with homogeneously distributed solid lubricant

deva.bm® sliding bearings are available in standard dimensions and as customized special parts. Customers benefit from our many years of experience in various applications and service in the field of material selection and design of special sliding bearings.

2.1 Microstructure and material composition

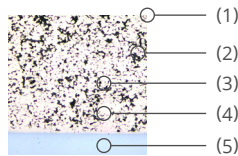
The high load capability of the steel backing and the bronze sliding matrix with homogeneously distributed lubricant incorporation is characteristic for deva.bm®. Depending on the material type, the percentage of solid lubricant as well as its particle shape and distribution varies. For use with conventional lubricants, the graphite-containing deva.bm® sliding layer can be additionally impregnated with oil.

For different requirements, we choose between four different microstructures.

The 4 deva.bm® microstructures

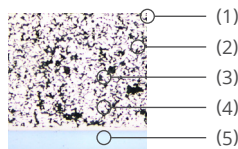
Low graphite content

- Very high static load
- Low number of sliding movements
- Ideal for additional lubrication



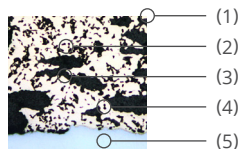
Intermediate graphite content

- Medium loads
- High sliding speeds



High graphite content and conditioned grain structure

- High loads
- High sliding speeds
- Very good ratio of wear resistance and load



PTFE as solid lubricant

- Very high loads
- Very high sliding speeds
- Low coefficient of friction in dry running

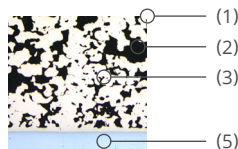


Figure 2.1.1

- (1) Sliding surface – standard with running-in film
- (2) Sintered bronze matrix

- (3) Solid lubricant
- (4) Optional oil impregnation (only for graphite alloys)

- (5) Steel backing

Properties of solid lubricants

	Graphite	PTFE
Crystalline structure	hexagonal	none
Specific gravity [g/cm³]	2.25	2.15 – 2.20
Coefficient of friction in air	0.1 – 0.18	0.01 – 0.30
Chemical resistance	very good	very good
Corrosion resistance	good	very good
Use in radioactive radiation	very good	poor
Use in air	very good	very good
Use in water	very good	good
Use in vacuum	poor	very good

Table 2.1.1

2.2 deva.bm® standard materials

For applications without special requirements in dry running, deva.bm® with a smooth sliding layer and running-in film is used. The running-in film reduces the coefficient of friction, especially in the running-in phase, and optimizes the wear behavior. The thickness of the running-in film is not taken into account when considering the bore tolerance because this coating is usually consumed during the running-in process.













deva.bm® (1)	Sliding layer material - Self-lubricating Sintered bronze with running-in film	Backing material	Min. compressive strength σ_M [N/mm ²]	Max. permissible stat. load $\bar{p}_{stat/max}$ [MPa]	Max. permissible dyn. load $\bar{p}_{dyn/max}$ [MPa]	Max. Sliding speed (dry) U_{max} [m/s]	Max. pU value (dry) $\bar{p}U_{max}$ [MPa x m/s]	Temperature range T [°C]	Friction coefficient (2) (3) depending on operating conditions μ	Minimum hardness of mating material [HB]	Recommended surface roughness of mating material Ra [μm]	Operating conditions	Available shapes
302	Low Graphite content 	1.4301	320	300	50 (150) (4)	0.1	0.4	-150 to 280	0.13 to 0.22	180	0.2 to 0.8	<ul style="list-style-type: none"> Standard for dry running and water lubricated applications Standard material for mechanical engineering; high static load, low number of cycles 	(a) (b) (c) (d) (e) (f)
372	Intermediate Graphite content 	1.4301	320	280	80	0.25	0.8	-150 to 280	0.11 to 0.18	180	0.2 to 0.8	<ul style="list-style-type: none"> General for dry running and water lubricated applications Medium load at high sliding speed 	(a) (b) (c) (d) (e) (f)
392	High Graphite content 	1.4301	300	280	100 (150) (4)	0.5	1.0	-150 to 280	0.10 to 0.16	180	0.2 to 0.8	<ul style="list-style-type: none"> General for dry running and water lubricated applications Abrasive environment 	(a) (b) (c) (d) (e) (f)
362/9P	PTFE as Solid lubricant 	1.4301	320	280	120	1.0	2.0	-190 to 250	0.05 to 0.13	180	0.2 to 0.8	<ul style="list-style-type: none"> General for dry running High dynamic load Available for bearings $D_1 \geq 28$ mm 	(a) (b) (c) (d) (e) (f)
Available designs		(a) 	(b) 	(c) 	(d) 	(e) 	(f) 						

Table 2.2.1

(1) Detailed material properties can be found in our material data sheets

(2) The given friction values are not guaranteed properties. They were determined on our test rigs using practical parameters. These do not necessarily have to correspond with the application of our products

and your application environment. We offer customer-specific friction and wear tests on request

(3) Axial bearings tend to have higher coefficients of friction than radial bearings

(4) Higher load capacity with dimples and grease or dg32 (see table 2.3.1)

2.3 Variants – macrostructure and different material compositions

In addition to the microstructure variants mentioned in 2.1 and the resulting basic materials (Chapter 2.2), additional options are available for the material structure. This results in a total of more than 44 deva.bm® variants from which to choose. Details are available on request in our material data sheets.







Macrostructure	Option available for	Description	Technical characteristics	Areas of application
Smooth sliding surface without running-in layer 	Graphite and PTFE alloys	The sliding surface is not coated with running-in film	<ul style="list-style-type: none"> Without running-in film, the coefficient of friction in the running-in phase is similar to or slightly higher than in the stationary operating phase 	<ul style="list-style-type: none"> Dry run Oil and water lubricated applications Low friction distances
With oil impregnation 	Graphite alloys	The residual porosity of the sintered material is additionally impregnated with oil	<ul style="list-style-type: none"> Oil impregnation improves the coefficient of friction and wear as long as the amount of oil in the pores is sufficient The operating temperature is max. 80 °C 	<ul style="list-style-type: none"> Oil and grease lubricated systems Applications with high sliding speeds
Alternative backing layers 	Graphite and PTFE alloys	Alternative support steel backing layers for different environmental conditions	<ul style="list-style-type: none"> 1.0338 (mild steel) 1.4301 standard stainless steel) 1.4571 with higher corrosion resistance (e.g., offshore) Bronze (CuSn6) 	<ul style="list-style-type: none"> Especially depending on the ambient medium and its influence on the corrosion of the material
Sliding layer With grooves 	Graphite and PTFE alloys	The sliding layer has a groove system. Groove depth: max. down to the support steel layer	<ul style="list-style-type: none"> Cleaning grooves Lubrication grooves 	<ul style="list-style-type: none"> Dusty environment Polluted water Additional lubrication
Sliding layer with Dimples 	Graphite alloys	The surface is provided with small calotte shape indentations as lubricant reservoirs ("dimples")	<ul style="list-style-type: none"> Higher pU value permissible with grease lubrication Longer service life with Grease lubrication Available for bearings $D_1 \geq 28$ mm 	<ul style="list-style-type: none"> For grease and oil lubricated applications, the dimples offer a longer service life
Dimples filled with dg32 	Graphite alloys	The dimples are filled with dg32, a hardening solid lubricant. Plus running-in film	<ul style="list-style-type: none"> Increase of the permissible dynamic load up to 150 MPa Higher pU value permissible Longer service life compared to the standard variant Available for bearings $D_1 \geq 28$ mm 	<ul style="list-style-type: none"> High dynamic loads To increase the service life compared to the standard variant

Table 2.3.1

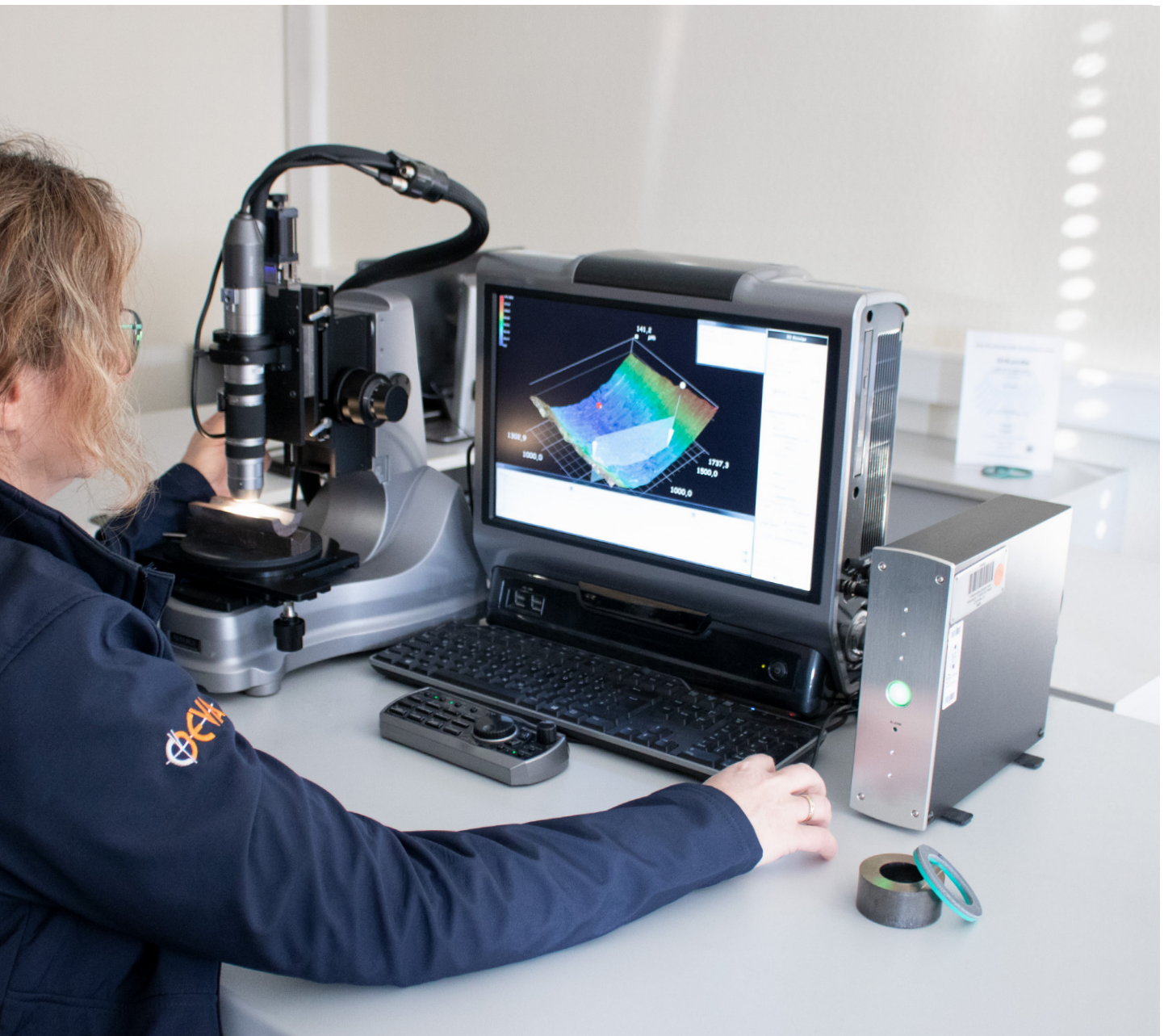
deva.bm® sliding bearings

Quality and certificates

Environmental protection and production safety

We attach great importance to qualitative, environmentally conscious and safe production. We are committed to this through the application of a variety of internationally recognized standards for quality assurance, emission control and workplace safety.

- RoHS and REACH compliant
- Certificate of origin
- Acceptance test certificates DIN EN 10204–2.1; 2.2; 3.1 and 3.2
- Certified according to ISO 9001; ISO 14001 and ISO 45001



deva.bm® sliding bearings

Load cases

The four cases of bearing load

DEVA® differentiates between four load cases. We do this to take into account the fatigue influences under dynamic load. The percentage values refer to the limit values given in the material data sheets and technical manuals.

The specifications should be understood as guide values. With alternation of loads in particular, the frequency and the number of cycles need to be considered with regard to the fatigue properties. Please contact us for a detailed analysis in a personal discussion.

Load case 0

The acting normal force is constant or can be assumed to be constant without frequent or rapid load changes or load alternations. There is no sliding movement.

Permissible limit load: 100% of the max. permissible static load according to material data sheet

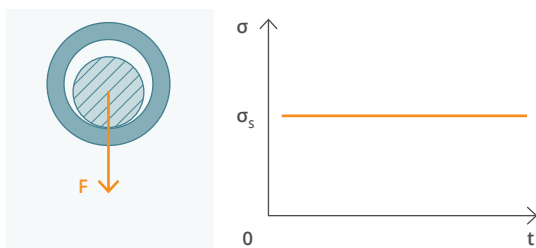


Diagram 4.1.1

Load case 1

The acting normal force changes frequently or quickly or oscillates strongly around a nominal force. There is no sliding movement.

Permissible limit load: 80% of the max. permissible static load according to material data sheet

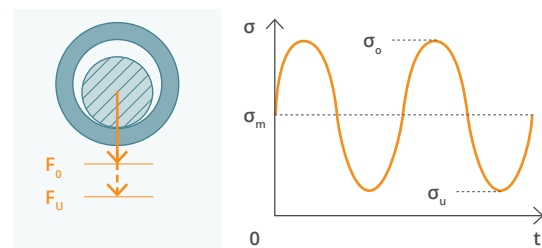


Diagram 4.1.2

Load case 2

The acting normal force is constant or can be assumed to be constant without frequent or rapid load changes or load alternations. In addition, a sliding movement takes place.

Permissible limit load: 100% of the max. permissible dynamic load according to the material data sheet

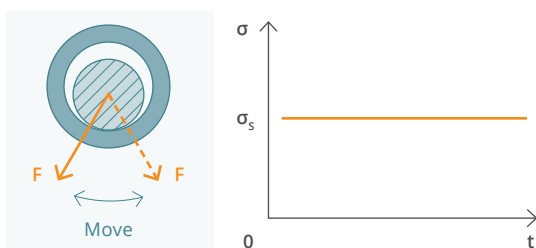


Diagram 4.1.3

Load case 3

The acting normal force changes frequently or quickly or oscillates strongly around a nominal force. In addition, a sliding movement takes place.

Permissible limit load: 100% of the max. permissible dynamic load according to the material data sheet

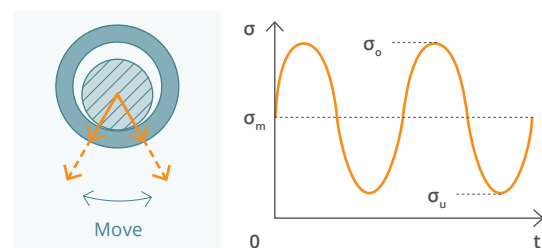


Diagram 4.1.4

deva.bm® sliding bearings

Mating materials

Roughness and surface finish

The deva.bm® sliding materials require the use of a mating material with a hardness of at least 180 HB. If the bearing is additionally lubricated, hardness values of >130 HB can also be permitted. In the case of abrasive effects from the environment, a hardened surface of 35 HRC/45 HRC should be used. The surface roughness is ideally $R_a = 0.2$ to $0.8 \mu\text{m}$, produced by grinding. Depending on the operating conditions, higher surface roughness can be accepted.

With regard to the surface finish, it is also possible to use protective sleeves with corresponding hardness. Overlay welding or other protective coatings (hard chrome plated, electroless nickel, etc.) can also be used under certain conditions. The corrosion requirements met by the mating material must be determined based on the individual operating conditions.

Roughness of the mating materials

Influence of the surface roughness of the mating material on the microwear of the sliding material
(Model representation from various investigations)

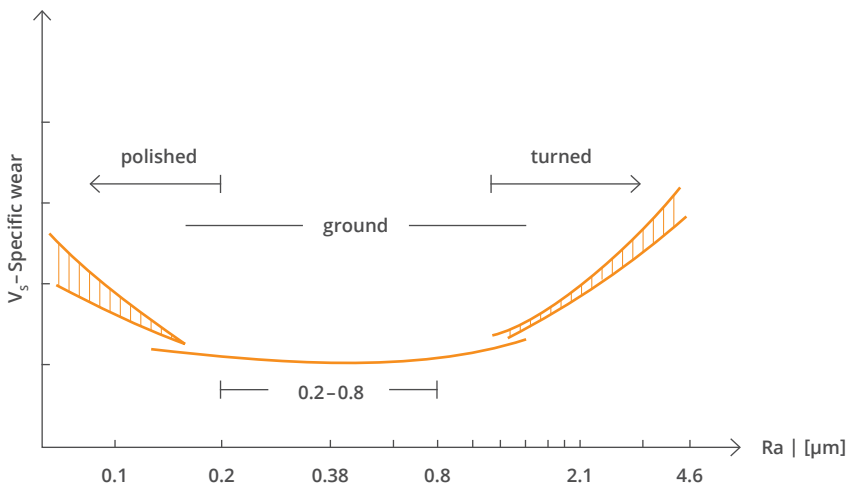


Diagram 5.1.1

Suggested materials

The following table gives an overview of some possible mating materials.

Material number	DIN designation	Comparable standards		
		USA - ANSI	GB - BS 970	F - AFNOR

Mating materials for normal applications

Material number	DIN designation	USA - ANSI	GB - BS 970	F - AFNOR
1.0543	ZSt 60-2	Grade 65	55C	A60-2
1.0503	C45	1045	080M46	CC45
1.7225	42CrMo4	4140	708M40	42CD4

Table 5.1.1

Mating materials for corrosive environment

Material number	DIN designation	USA - ANSI	GB - BS 970	F - AFNOR
1.4021	X20Cr13	420	420S37	Z20C13
1.4057	X17CrNi-16-2	431	432S29	Z15CN16.02
1.4112	X90CrMoV18	440B	-	(Z70CV17)
1.4122	X35CrMo17	-	-	-
1.4418	X4CrNiMo16-5-1	S165M	-	Z6CND16-05-01

Table 5.1.2

Mating materials for use in seawater

Material number	DIN designation	USA - ANSI	GB - BS 970	F - AFNOR
1.4462	X2CrNiMoN22-5-3	UNSS531803	318513	Z3CND24-08
1.4501	X2CrNiMoCuWN25-7-4	UNSS32760	-	Z3CND25.06Az
2.4856	Inconel 625	-	-	-

Table 5.1.3

deva.bm® sliding bearings

Cylindrical sliding bearings

6.1 Recommended standard dimensions

The sizes marked in table 6.1.1 are available as standard for most alloys listed in this manual. Special dimensions and tolerances for special applications can also be manufactured.

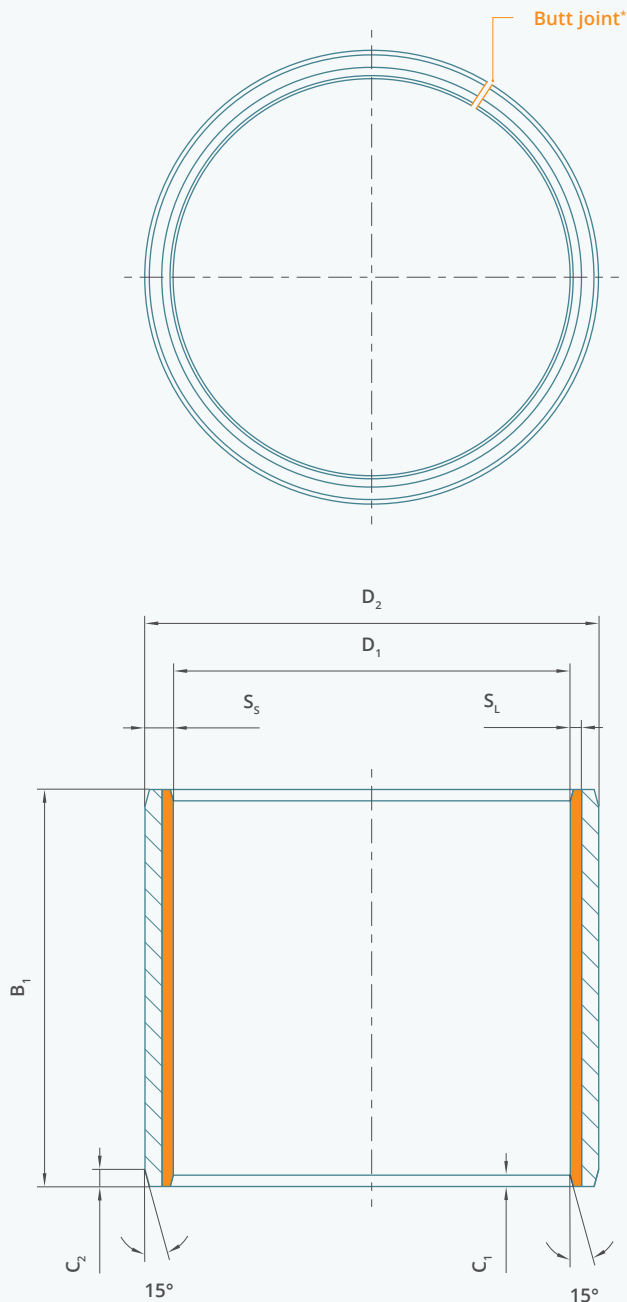


Figure 6.1.1

* Butt joint must not be in load direction

B_1 – Bearing width
 C_1 – Inner chamfer
 C_2 – Outer chamfer

D_1 – Inner diameter
 D_2 – Outer diameter

S_s – Wall thickness
 S_L – Sliding layer thickness

Bore tolerance (after installation)	Nominal dimensions in mm						Bearing width B_1 (± 0.25 mm) in mm																					
	D_1	D_2	S_s	S_L	C_1	C_2	10	15	20	25	30	40	50	60	70	80	100	120	140	150	160	180	200					
H9	10	12	1.0	≥ 0.40	0.7	0.5	●	●																				
	12	14					●	●																				
	14	16					●	●	●																			
	15	17					●	●	●	●																		
	16	18					●	●	●	●	●																	
	18	20					●	●	●	●	●	●																
H8	20	23	1.5	≥ 0.50	1.0	0.6	●	●	●	●	●																	
	22	25					●	●	●	●	●																	
	24	27					●	●	●	●	●	●																
	25	28					●	●	●	●	●	●																
	28	32	2.0	≥ 0.75	1.5	0.8	●	●	●	●	●	●																
	30	34					●	●	●	●	●	●																
	32	36					●	●	●	●	●	●	●															
	35	39					●	●	●	●	●	●	●	●														
	36	40					●	●	●	●	●	●	●	●	●													
	38	42					●	●	●	●	●	●	●	●	●	●												
40	44	●	●	●	●	●	●	●	●	●	●	●																
42	46	●	●	●	●	●	●	●	●	●	●	●	●															
H8 (precision)/H9 (standard)	45	50	2.5	≥ 0.70	1.8	1.0	●	●	●	●	●	●	●	●														
	50	55					●	●	●	●	●	●	●	●	●	●	●											
	55	60					●	●	●	●	●	●	●	●	●	●	●	●										
	60	65					●	●	●	●	●	●	●	●	●	●	●	●	●									
	65	70					●	●	●	●	●	●	●	●	●	●	●	●	●	●								
	70	75					●	●	●	●	●	●	●	●	●	●	●	●	●	●								
	75	81	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●											
	80	86	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●										
	85	91	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●									
	90	96	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●								
	95	101	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●							
	100	106	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●						
	105	111	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●					
	110	116	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●				
	115	121	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●				
	120	126	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●				
	125	131	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●				
	130	136	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●				
135	141	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●					
140	146	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●					
145	151	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●					
150	156	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●					
160	166	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●					
180	186	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●					
200	206	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●					
220	226	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●					
240	246	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●					
250	260	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●					
...	$D_1 + 2 \times SB$	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●					
800	810	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●					

Table 6.1.1

● = Recommended dimensions (other dimensions on request)

deva.bm® Sizes – Information

- deva.bm® sliding bearing, $D_1 > 550$ mm, laser welded, additionally secured
- Very large deva.bm® bearings are manufactured in segments
- deva.bm® with Dimples and deva.bm® 362/9P $D_1 \geq 28$ mm producible
- The maximum width for deva.bm® 362/9P is $B_1 = 190$ mm
- Cross cleaning grooves are available from $D_1 > 20$ mm

Other sizes available upon request.

deva.bm® Recommendation

Due to a lack of frictional fixation, bearings of a length $\leq \frac{1}{4} D_1$ are recommended to be mechanically secured against slipping/twisting inside the housing, e.g., by cylindrical pins.

6.2 Fits and surfaces

The tolerance of the sliding bearing outer diameter and the H7 bore tolerance of the housing results in an interference fit. The shrinkage of the inner diameter during the installation of the bushing is already taken into account in the design and manufacture of the sliding bearing. Therefore, we always speak of inner tolerance after installation.

Permissible fit and tolerance ranges

Figure/Table 6.2.1 shows the recommended fit and tolerance options. For a more accurate fit after assembly (IT7 or better), finish machining should be done after installation. For this purpose deva.bm® can be produced with a machining allowance. In this case, the running-in film should be applied after machining. **Other tolerances, e.g., for h7 shafts, are available on a customer-specific basis.**

Surface finish of deva.bm®

According to DIN 30910 for sintered metals, roughness specifications according to DIN 4768 or DIN 4771 are not possible due to the low residual porosity and the solid lubricant deposits. Specifications on our drawings are only for orientation and for setting process parameters in production, but are not guaranteed values.

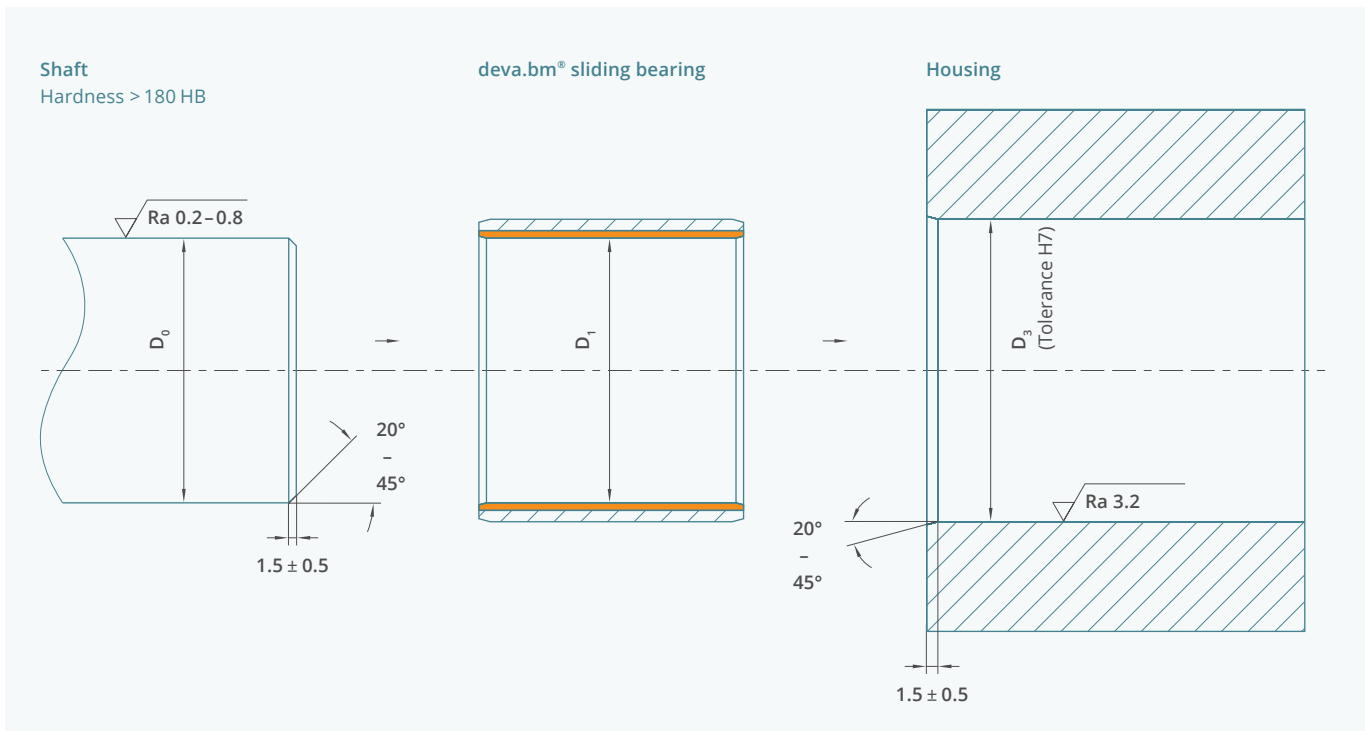


Figure 6.2.1

Inside diameter D_i Nominal dimension [mm]	D_i Tolerance without running-in film in installed condition	Shaft D_0	
		Normal applications	Accuracy applications
< 20	H9	d7	e7
≥ 20 to < 45	H8	d7	e7
≥ 45	H9 (standard) / H8 (precision)	d7	e7

Table 6.2.1

6.3 Installation by means of press-fitting

deva.bm® radial sliding bearings are installed by pressing them in using a hydraulic press or a spindle press. Press-fit tools (press-fit mandrel, guide bush) are required for this purpose as shown in Figure 6.3.1..

Installation instruction

- Light oiling of the housing bore, bearing outside diameter and guide bush assists fitting and protects the components against seizure
- First, insert the sliding bearing into the guide bush until it protrudes a few millimeters on the mounting side
- Now the arrangement can be centered on the housing
- The force must be applied evenly to the sliding bearing via the press-fit mandrel in order to avoid tilting. Installation using an impact tool (hammer) is not permissible, as this can lead to damage to the sliding bearing

We would be pleased to provide you with further information and documentation relating to sliding bearing mounting. Please contact us!

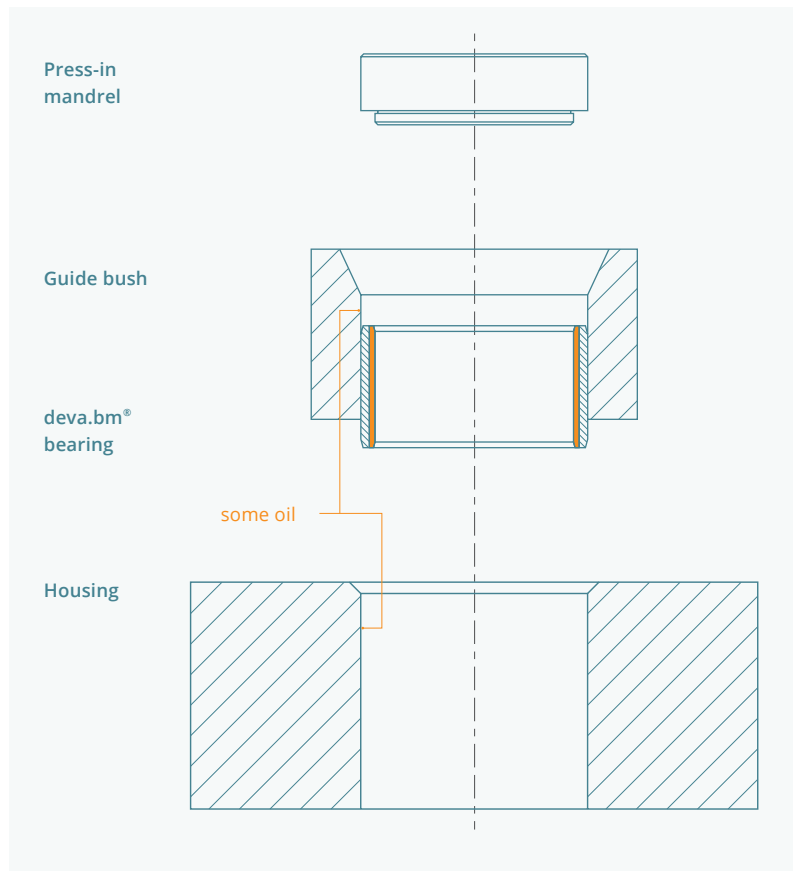
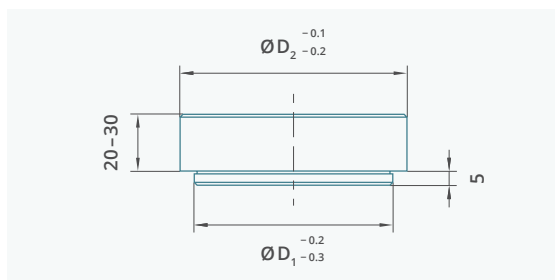


Figure 6.3.1

Design layout of the press-in mandrel

For standard and precision bearings



For bearings with machining allowance

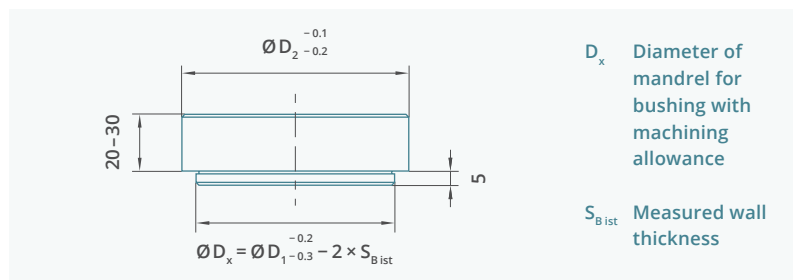


Figure 6.3.2

Design layout of the guide bush

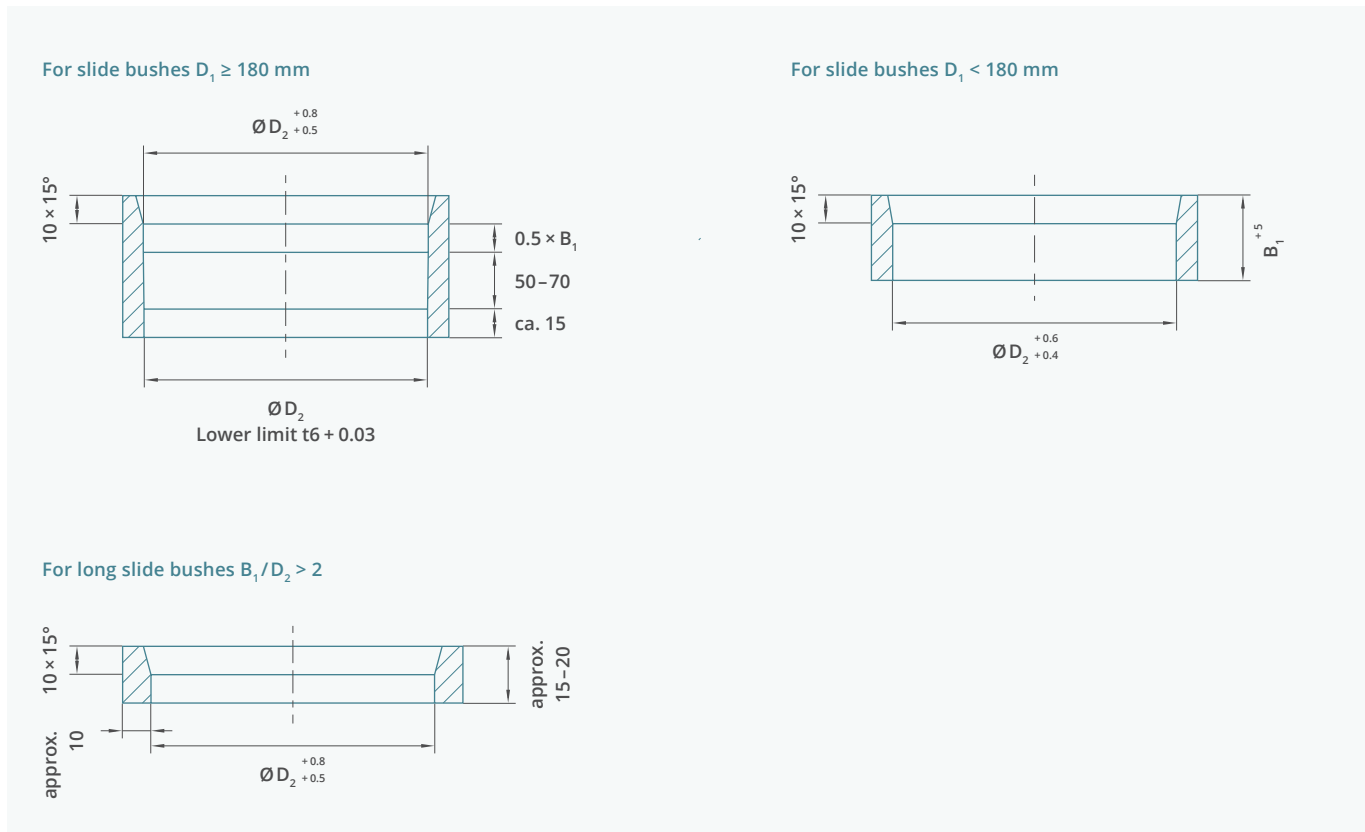


Figure 6.3.3

6.4 Installation by supercooling with liquid nitrogen

deva.bm® sliding bearings with outside diameter $D_2 > 200$ mm can be installed by supercooling with liquid nitrogen. Detailed mounting instructions are available on request also for dry-ice.



deva.bm® sliding bearings

Sliding plates and segments

7.1 Dimensions of sliding plates

deva.bm® sliding plates are available in standard materials (chapter 3.2) as well as in most variants (chapter 3.3). Only finish machined sliding plates and segments are available. Our blanks, from which we manufacture the parts, have the following dimensions (see table). If these dimensions are exceeded, multi-part solutions are possible.

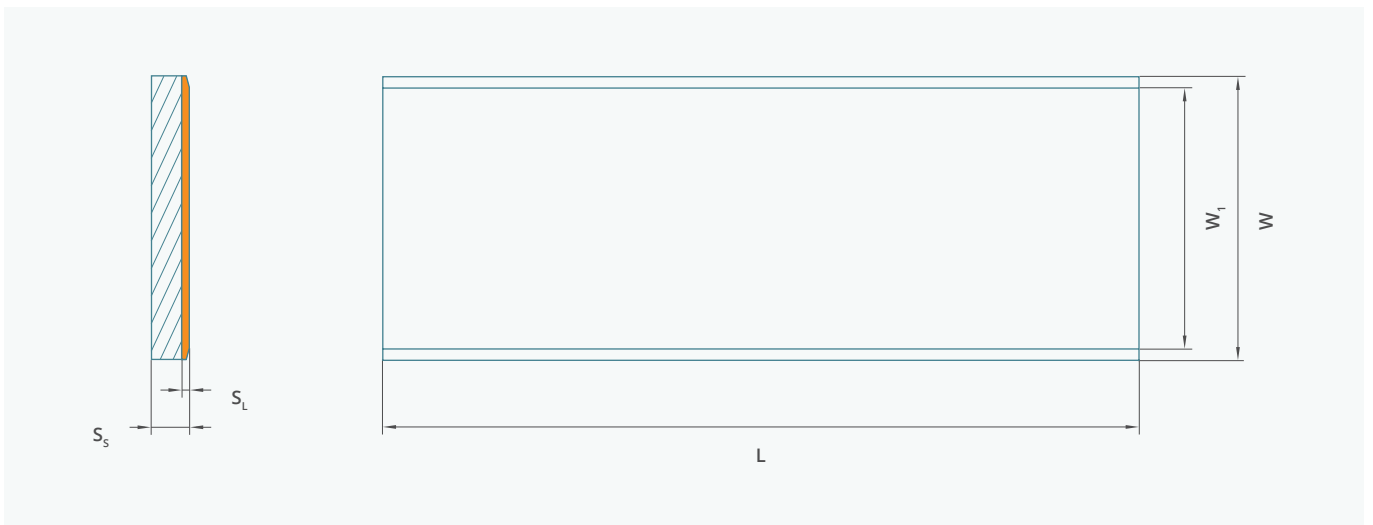
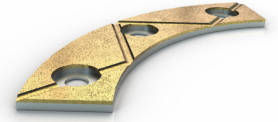


Figure 7.1.1

Dimensions deva.bm® plates

Plate thickness S_s [mm]	Wall thickness tolerance [mm]	Min. sliding layer thickness S_L [mm]	Usable width W_1 [mm]	Usable length [mm]
2.5	± 0.05 ⁽¹⁾	0.65	200 (190) ⁽²⁾	1750
3.0	± 0.05	0.95	200 (190) ⁽²⁾	1750
5.0	± 0.05	1.45	200 (190) ⁽²⁾	1750
10.0	± 0.05	1.95	190 (180) ⁽²⁾⁽³⁾	1000

Table 7.1.1

- (1) Other tolerances possible
- (2) The values in brackets apply to deva.bm® 362/9P
- (3) For sliding plates with a thickness of 10 mm, the following should be noted: For plates the useful width can be increased slightly,

if chamfers $3 \times 45^\circ$ are considered in the design. For all other parts (segments, thrust washers, etc.), which are to be manufactured from a blank, the specified useful width applies

7.2 deva.bm® contour parts

The smallest bending radius for deva.bm® depends on the total thickness and the ratio between steel backing and sliding layer thickness.

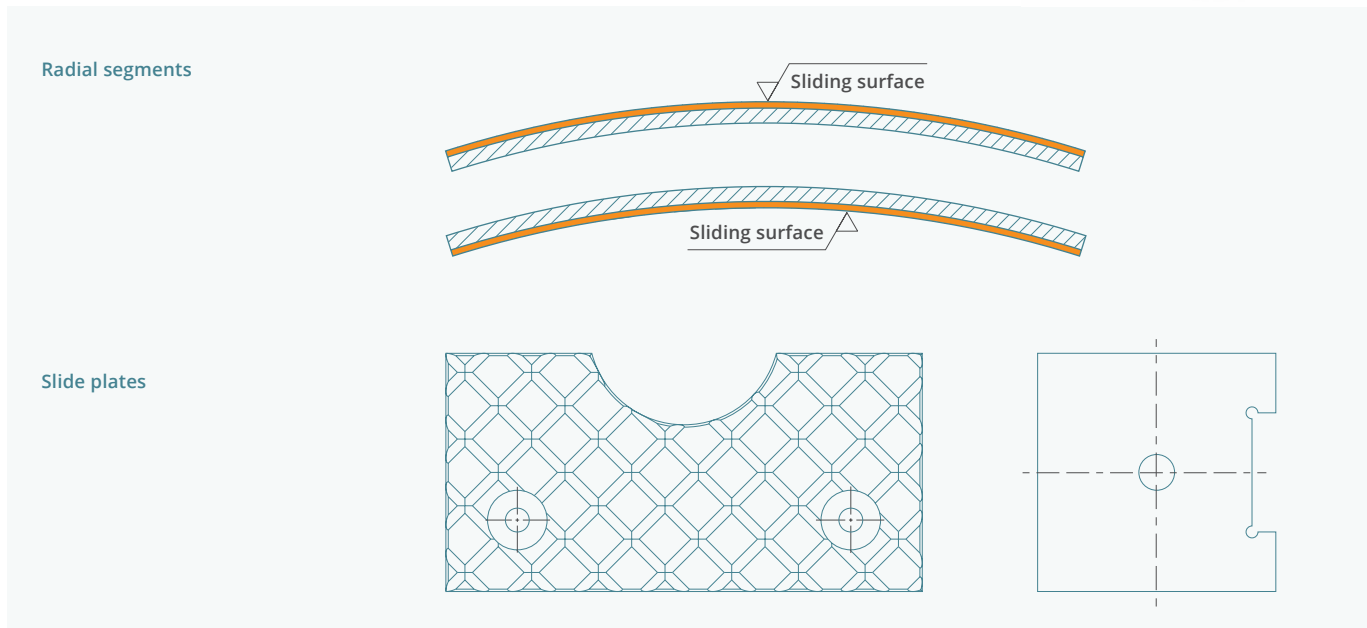


Figure 7.2.1

Manufacturing restrictions of deva.bm® radial segments

Segment thickness ⁽¹⁾ [mm]	Min. bending diameter with sliding layer [mm]	
	Inner diameter	Outer diameter
1.0	10	– ⁽²⁾
1.5	20	– ⁽²⁾
2.0	28	– ⁽²⁾
2.5	45	– ⁽²⁾
3.0	75	600
5.0	250	800

Table 7.2.1

(1) Other thicknesses on request

(2) Upon request

7.3 Design rules for fastening with countersunk screws

The following design rules for the installation of deva.bm® sliding plates 2, 2.5, 3 and 5 mm thick with countersunk screws need to be considered. The figure shows the design of carrier and sliding plate.

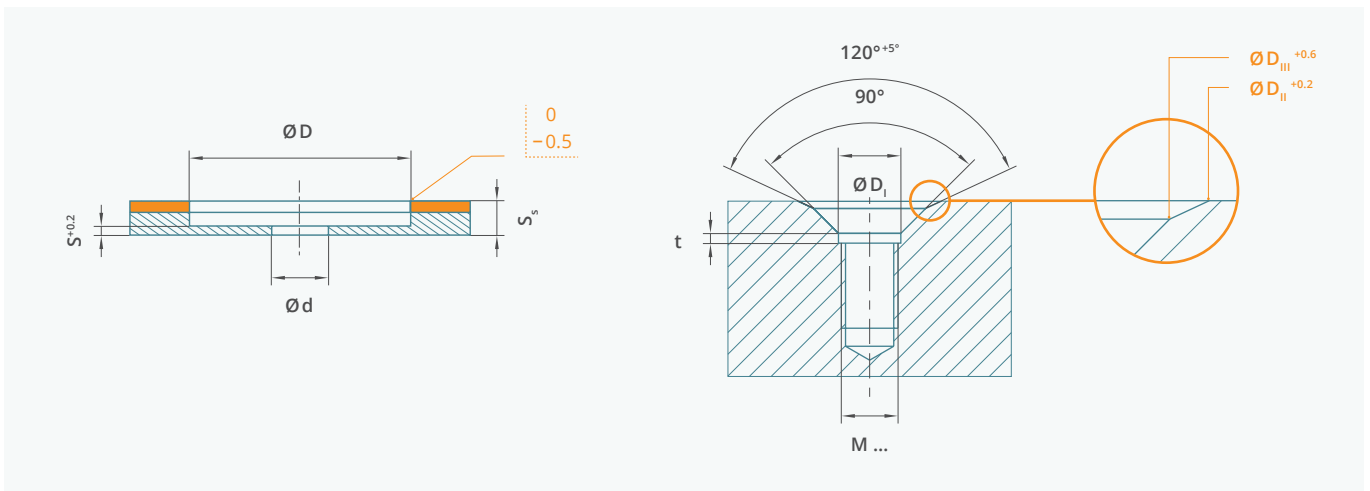


Figure 7.3.1

Thread according to DIN 13	Nominal dimensions [mm]									Tolerance for distance between holes for supporting part and deva.bm® [mm]
	d	D	D _I	D _{II}	D _{III}	t	S _s	S _{un alloyed}	S _{stainless steel}	

Installation dimensions for screws according to DIN EN ISO 2009 and DIN EN ISO 7046-1

M5	5.3 ⁽¹⁾	11	-	9.5	10.5	-	2	0.8	0.8	±0.10
M6	6.4	13	-	11.5	12.5	-	2/2.5	0.8	0.8	±0.10
M8	8.4	17	-	15.0	16.0	-	2.5/3	1.0	0.8	±0.10
M10	10.5	21	-	18.5	19.5	-	3/5	1.0	0.8	±0.15
M12	13	25	-	22.5	23.5	-	5	1.0	0.8	±0.15

Table 7.3.1

Installation dimensions for screws according to EN ISO 10642

M5	5.3 ⁽¹⁾	13.5	6	11.5	12.5	1.0	2	0.8	0.8	±0.10
M6	6.4	16	7	14.0	15.0	1.5	2/2.5	0.8	0.8	±0.10
M8	8.4	20	9	18.0	19.0	2.0	2.5/3	1.0	0.8	±0.10
M10	10.5	25	11	22.0	23.0	2.5	3/5	1.0	0.8	±0.15
M12	13	29	13	26.5	27.5	3.0	5	1.0	0.8	±0.15

Table 7.3.2

(1) Deviating bore tolerance Ød: ±0.15 mm (is not acc. to general tolerance)

Design guideline for hole spacing

Size and quantity of screws is determined by the occurring loads and the resulting shear forces to be absorbed.

Arrangement examples

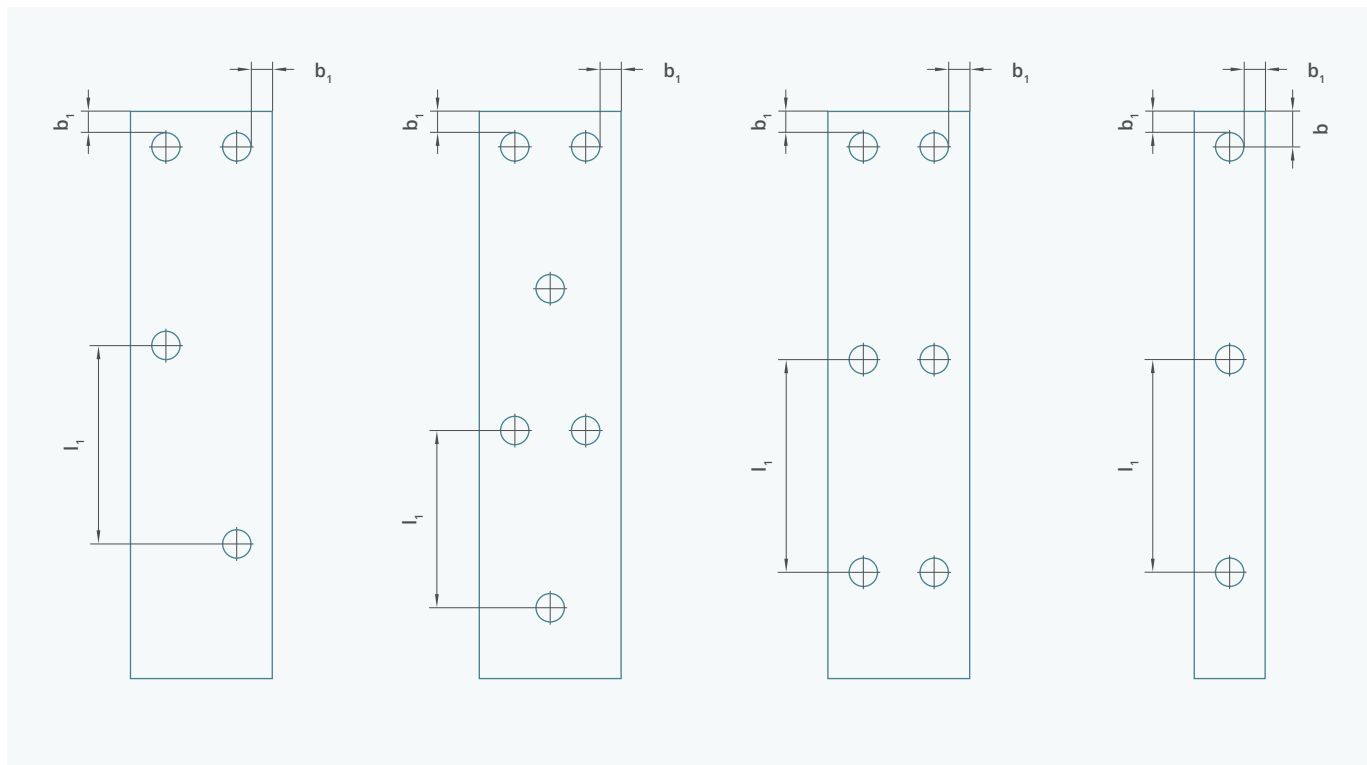


Figure 7.3.2

Maximum milling depth for deva.bm® for $b_1 < 4$ mm

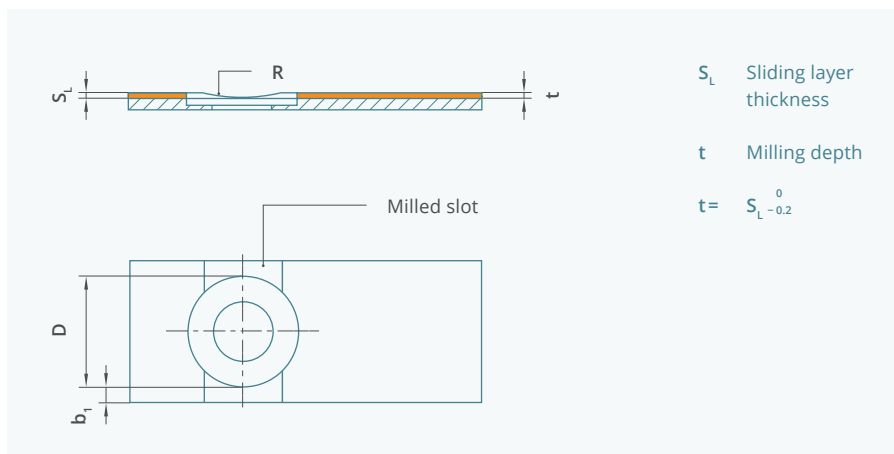


Figure 7.3.3

Recommendation Reference values

$l_r = 60$ to 150 mm

$b = (1$ to $1.5) D$

$b_1 = 10$ to 30 mm
 if $b_1 < 4$ mm
 a relief cut should
 be considered as
 shown in Figure 7.3.3
 to avoid edge chipping

7.4 Installation description

Before tightening the screws, it is recommended to fix the deva.bm® sliding plate in place with a pressure plate and to pre-punch the countersink in the deva.bm® with tools according to DEVA® standard 3.33-1 (available upon request). Tighten alternately on the left and right sides, in relation to the centre.

We will be pleased to support you with regard to suitable assembly tools.
Please contact us.

Pressure plates

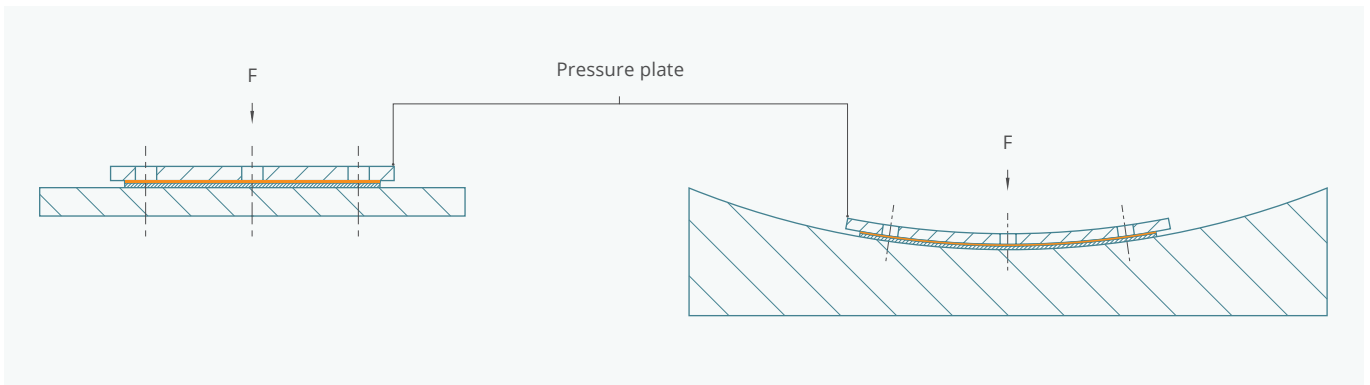


Figure 7.4.1

Screw connection

The screws should be secured with "Loctite 243" for medium strength or "Loctite 278" for high strength.
The temperature limits and processing instructions of the manufacturer must be considered.

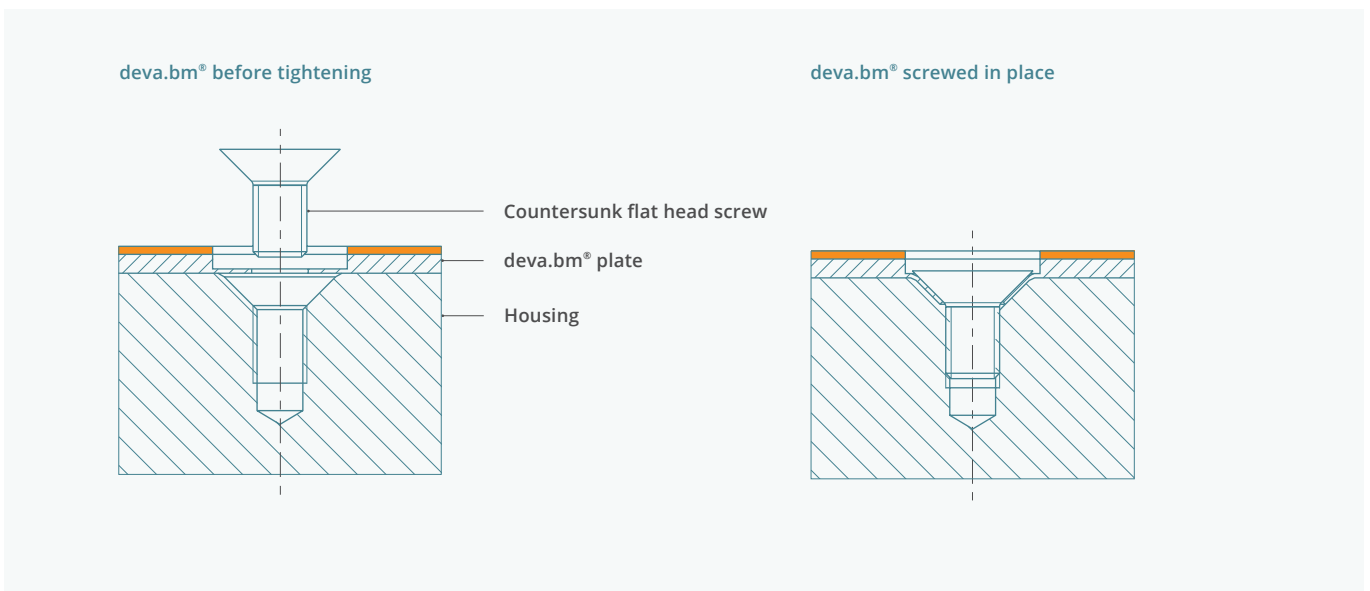


Figure 7.4.2

7.5 Installation of deva.bm® sliding strips with 10 mm thickness

Installation deva.bm® 10 mm sliding plate with M10 countersunk screws according to EN ISO 10642.

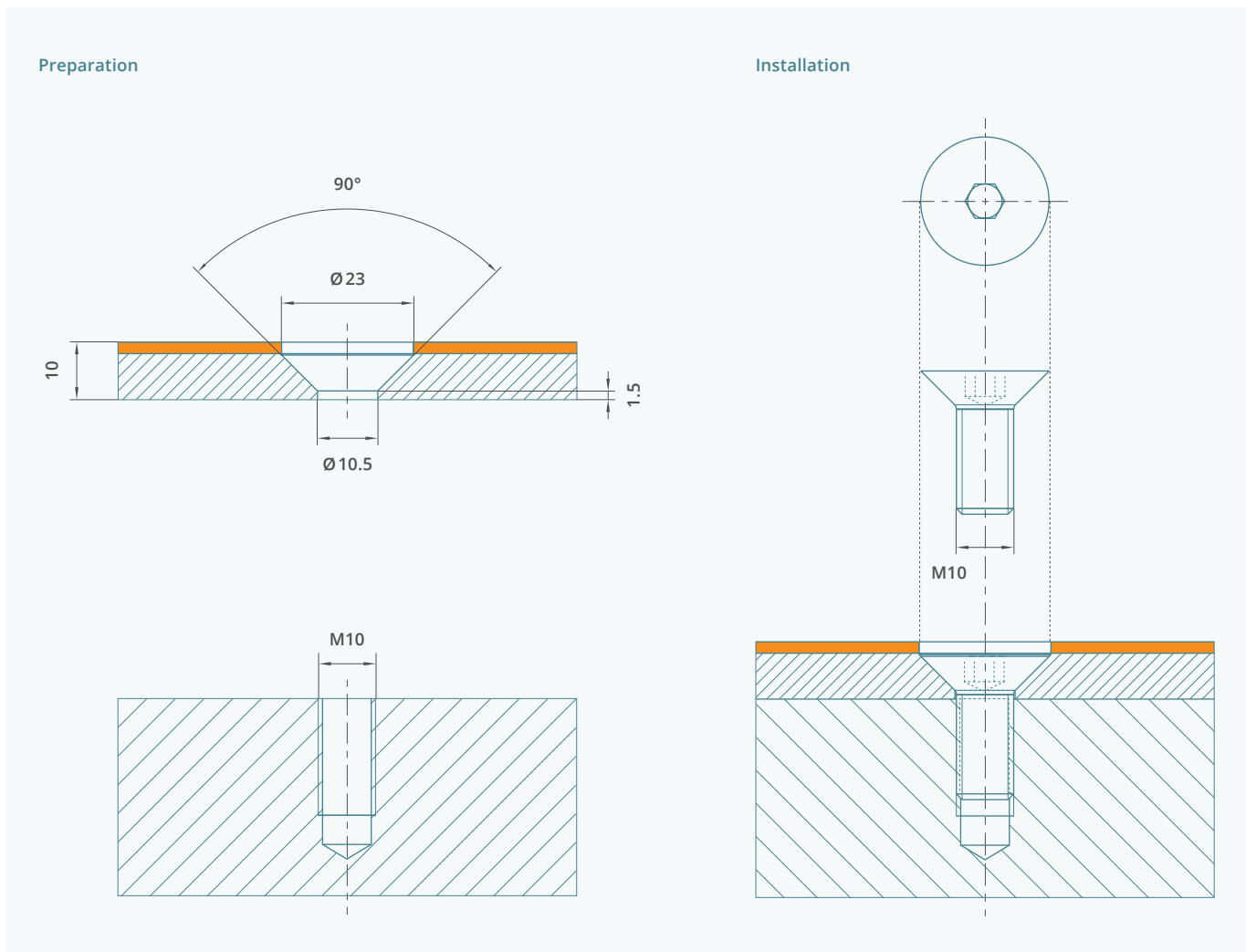


Figure 7.5.1

deva.bm® sliding bearings

Chemical resistance

deva.bm® and various substances

Table 8.1.1. provides information about the chemical resistance of deva.bm® alloys. Definitive statements about the actual behavior can only be made by carrying out operational tests.

Medium/ chemical substance	Concentration [%]	Temperature [°C]	deva.bm® alloys		
			with 1.4301 steel backing	with 1.0338 steel backing	with 1.4571 steel backing
Strong acids					
Hydrochloric acid	5	20	✗	✗	✗
Hydrofluoric acid	5	20	○	✗	○
Nitric acid	5	20	✗	✗	✗
Sulphuric acid	5	20	●	✗	●
Phosphoric acid	5	20	●	✗	●
Weak acids					
Acetic acid	5	20	●	✗	●
Formic acid	5	20	●	✗	●
Boric acid	5	20	●	✗	●
Citric acid	5	20	●	✗	●
Bases					
Ammonia	10	20	✗	✗	●
Potassium hydroxide	5	20	●	✗	●
Sodium hydroxide	5	20	●	✗	●
Solvent					
Acetone		20	●	✗	●
Carbon tetrachloride		20	●	✗	●
Ethyl alcohol		20	●	✗	●
Ethyl acetate		20	●	✗	●
Ethyl chloride		20	●	✗	●
Glycerine		20	●	○	●
Salts					
Ammonium nitrate			✗	✗	●
Calcium chloride			●	✗	✓
Magnesium chloride			●	✗	○
Magnesium sulfate			●	✗	●
Sodium chloride			●	✗	●
Sodium nitrate			●	✗	●
Zinc chloride			✗	✗	○
Zinc sulfate			●	✗	●

Table 8.1.1

Medium/ chemical substance	Concentration [%]	Temperature [°C]	deva.bm® alloys		
			with 1.4301 steel backing	with 1.0338 steel backing	with 1.4571 steel backing
Gases					
Ammonia gas			○	✗	✓
Chlorine gas			✗	✗	○
Carbon dioxide			●	✗	●
Fluorine			✗	✗	✗
Sulphur dioxide			●	✗	●
Hydrogen sulfide			○	✗	○
Nitrogen			●	✗	●
Hydrogen			●	✗	●
Lubricants/Fuels					
Paraffin		20	●	●	●
Petrol		20	●	●	●
Heating oil		20	●	●	●
Diesel		20	●	●	●
Mineral oil		70	●	●	●
HFA ISO46		70	●	●	●
Oil Water Emulsion					
HFC Water Ethylene		70	●	●	●
HFD Phosphate ester		70	●	●	●
Other					
Water		20	●	✗	●
Seawater		20	○	✗	●
Resin			●	●	●
Hydrocarbon			●	✗	●

Table 8.1.1

- Resistant
- Conditionally resistant, depending on environmental conditions
- ✗ Not recommended
- ✓ No data available

deva.bm® sliding bearings

Design examples and applications

deva.bm® radial segment, including fastening, screw connection

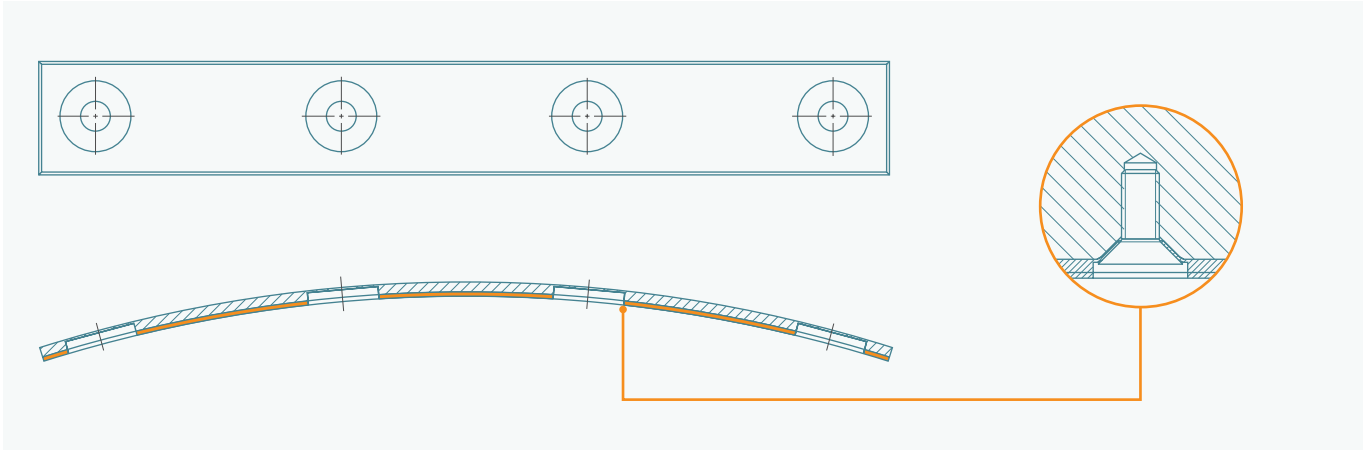


Figure 9.1.1

deva.bm® axial segment with cleaning grooves

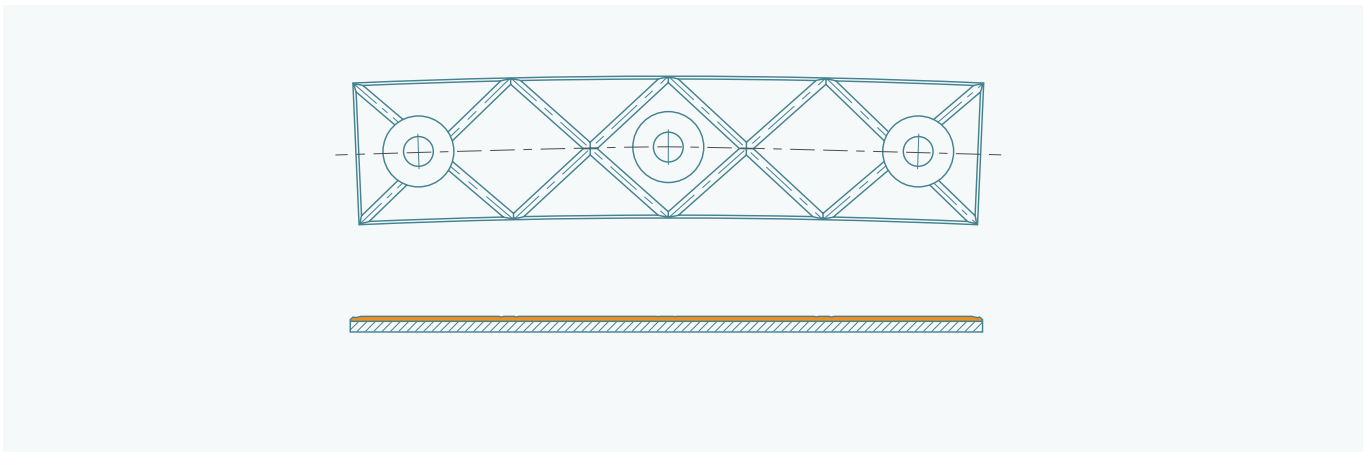


Figure 9.1.2



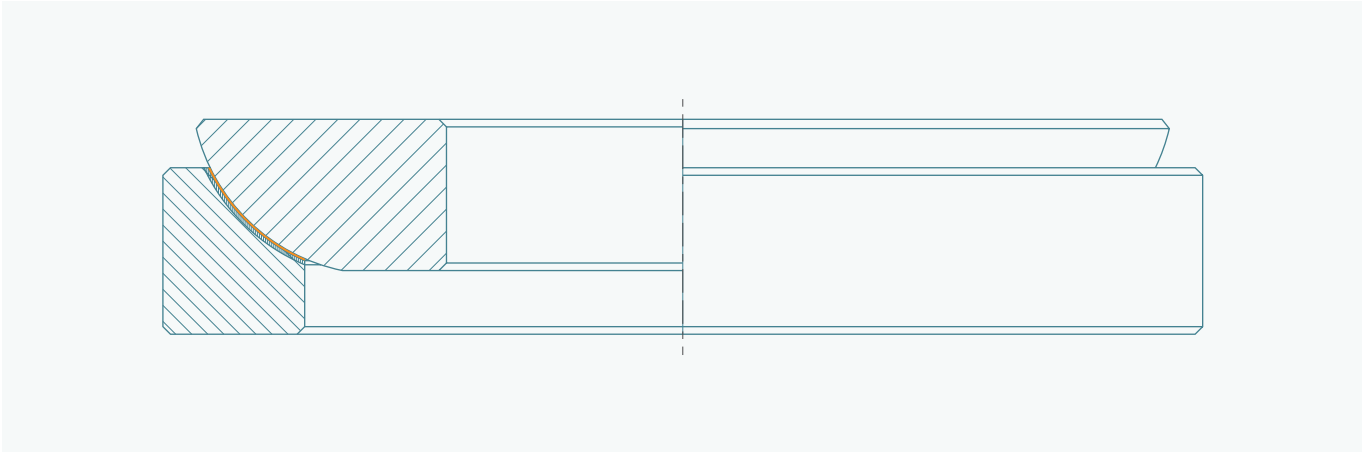
deva.bm[®] calotte bearing

Figure 9.1.3

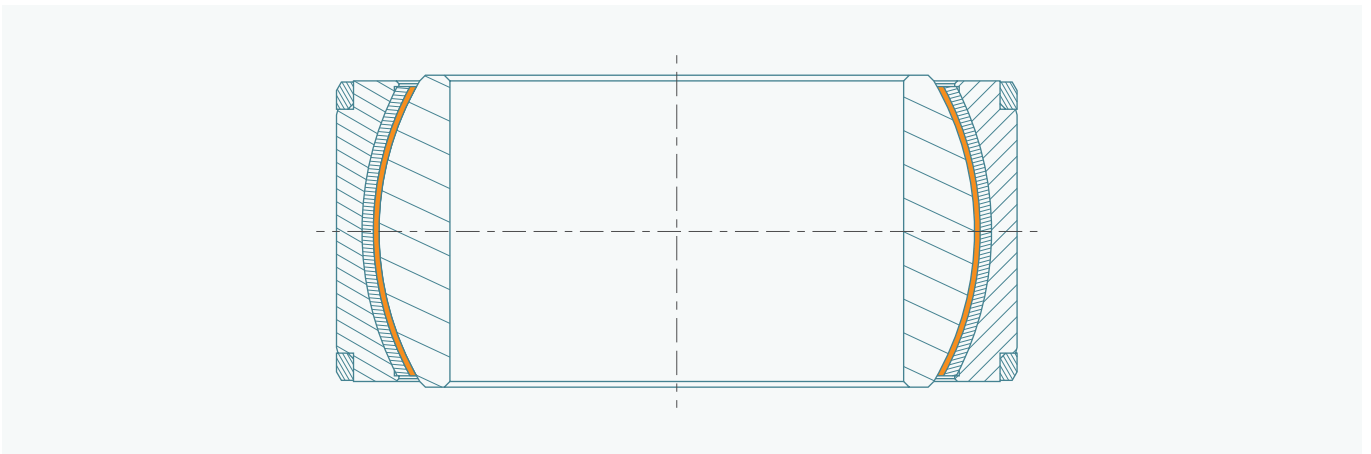
deva.bm[®] spherical bearing

Figure 9.1.4



deva.bm® sliding bearings

Data for the design of DEVA® sliding bearings

Personal data

Company name _____

Project number _____

Address _____

Contact person _____

Phone _____

Fax _____

Mobile phone _____

Email _____

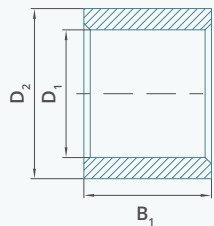
Description of the application

- New design
- Existing design
- Steel industry
- Wind energy
- Rubber and plastics industry
- Steam and Gas Turbines
- Offshore and Marine
- Heavy-duty Vehicles
- Railway
- Hydro Power
- Other

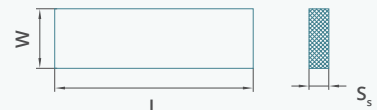
Bearing type

- Shaft rotates
- Bearing rotates
- Angular motion
- Axial motion

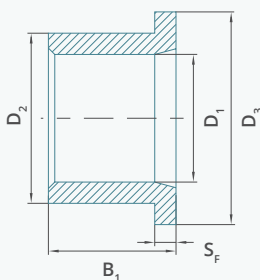
Bushing



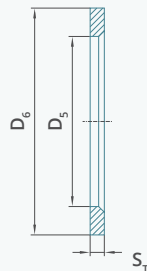
Sliding plate



Flanged bushing bearing

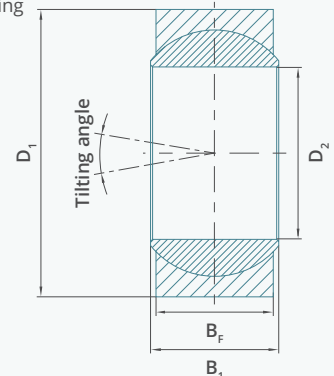


Thrust washer



Spherical bearing

- Floating bearing
- Fixed bearing



	Pos. 1	Pos. 2	Pos. 3
Quantity			
Dimensions [mm]			
Inner diameter D_1 (D_5)			
Outer diameter D_2 (D_6)			
Bearing width B_1			
Outer ring width B_r			
Flange outer diameter D_3			
Flange thickness S_f			
Wall thickness S_T			
Plate length L			
Panel width W			
Plate thickness S_s			
Load			
Static	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Dynamic	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Alternating	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Shock loads	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Radial load [kN]			
Axial load [kN]			
Surface pressure			
Radial [MPa]			
Axial [MPa]			
Mating material			
Material no./type			
Hardness [HB/HRC]			
Roughness R_a [μm]			
Housing material			
Material no./type			

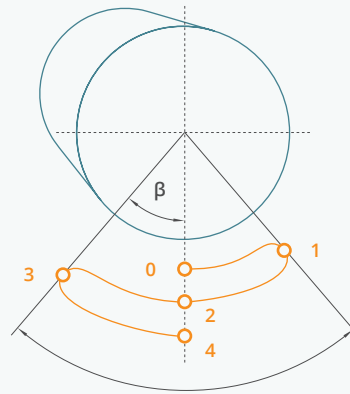
	Pos. 1	Pos. 2	Pos. 3
Lubrication			
Dry run	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Permanent lubrication	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Medium lubrication	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Medium Lubricant			
Initial lubrication	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Hydrodynamic lubrication	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Dynamic viscosity			
Move			
Speed [rpm]			
Sliding speed [m/s]			
Stroke length [mm]			
Double strokes [/min]			
Rotation angle [°]			
Frequency [n/min]			
Tilt angle (spherical bearing) [°]			
Operating time			
Continuous operation			
Intermittent operation			
Duty operation [%/h]			
Days/Year			
Frictional distance [km]			
Fits/Tolerances			
Shaft			
Bearing housing			
Environmental conditions			
Temperature at bearing			
Contact medium			
Other influences			
Lifetime			
Desired operating time [h]			
Permissible wear [mm]			

Angle

The angle β is defined by the movement from the middle position to one end point.

Cycle

A cycle is four times the angle β . The calculation of the expected friction distance is based on this.

**Example**

Bushing $D_i = 50$ mm and angle $\beta = 5^\circ$
1 cycle shows a friction distance of 8.73 mm

Disclaimer

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Maintenance-free, self-lubricating sliding bearings

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